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Applications of MultiMedia Communications Systems to Health Care Transaction Management

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Abstract

The use of imaging technology has been focused primarily in the areas of diagnosis. There have been recent developments in combining this basic technology with two other technology areas: databases and communications. The database elements provide the basis of PACs systems, and the communications elements have been directed towards terminal-to-terminal connection. This paper presents the results of a trial in the Boston area among four major hospitals to determine the impact of a multimedia communications system that deals with multiple image modalities and, at the same time, is integrated into the Hospital Information Systems. The results of this effort fall into two major categories. The first demonstrates the effectiveness of multimedia communications as an integrating and expanding technology that allows for more effective diagnostic methods. The second is a detailed study of the cost impact of such systems. The primary conclusion is that, under certain specific patient loads, the use of this technology in combination with a HIS (Hospital Health Information System) results in a 40% cost savings. A secondary conclusion from the study is that this system also allows for the integration of a full transaction-based capability into the hospital and, thus, has significant impact on the hospital's working capital management problem. It is believed that this is the first study that has addressed the fully integrated imaging and transaction impacts from both an operational and cost perspective.

1.0 Introduction

Imaging in the hospital environment has taken on various modalities, ranging from plain file techniques through MRI, CAT, PET, Nuclear Medicine and other forms. The processing of these images has been primarily focused on the diagnostic aspects and, generally, the focus is on a single set of images in the context of the current diagnosis. The introduction of PACs systems was driven by the need for better image management of existing images, and the ability to retrieve these images once stored. The focus of a PACs system is generally on the management of plain film systems, although it has been expanded in certain cases to include other modalities.

The concerns of the Radiologist are frequently different from those of the attending physician or of the specialists on consult. Generally, the latter are more interested in the combination of diagnostic data--the imaging portion being just one element of the entire set. Thus, PACs serves the specialist, and in most cases, does not impact the needs of the other physicians. More importantly, the PACs systems are not integrated into the overall Hospital Health Information System (HIS). The HIS provides for the maintenance and updating of patient records; in addition, it must also be viewed as the transaction processing system for the hospital. An HIS terminal is, in effect, a Point of Service (POS) terminal that, if properly integrated, can be an integral part of the hospital's overall financial management system.

In this paper, we present the results of a one-year effort with four hospitals in Boston. These hospitals are Brigham and Women's, Childrens Hospital, Massachusetts General and the New England Medical Center. The trial was focused on the ability to provide a multimedia communications system that provided both intra- and inter-premise information systems that were integrated into the hospitals' information systems. The trial has the following objectives:

- To determine the usefulness of electronic imaging to both the imaging specialist and attending physician.

- To evaluate the effectiveness of shared conversational environment for the determination and evaluation of patient records and evaluation of the patient condition.

- To evaluate the cost effectiveness of incorporating an electronic imaging system into a fully integrated Hospital Information System.

- To determine what the performance factors for a fully integrated system would be and to develop models for the projection of performance and system sizing.

- To understand the ability to integrate a transaction-based system into the hospital environment. The emphasis here was on the ability to record each procedure, relate it to the appropriate CPT and DRG codes, and to tie this in with a real-time billing capture system.

This paper presents a summary of several of the key findings of this study. As indicated, our emphasis was not just on the technology, but also on the end user acceptance as well as the operational and financial impact of the system on hospital operations.

2.0 Imaging Environment

The imaging environment consists of multiple modalities at multiple locations. A great deal of effort has already been expended on imaging management and storage systems. PACs systems are typically focused on the management and storage of plain film type images, and they are directed on improving the productivity of the imaging specialist. The current system that has been developed uses PACs as a set of input and data storage elements, but does not, in any way, try to duplicate the PACs functionality. In this specific network, the following types of image modalities are connected:

- Plain Film: This is a digitized plain film system that is used in several of the institutions.

- MRI: The MRI systems are present in Massachusetts General Hospital and Brigham Women's and are connected to remote reading and processing facilities. In the case of the Brigham and Women's, the connections will tie back to the Connection Machine supercomputer on the MIT campus.

• CAT: The standard CAT interfaces using ACR-NEMA interfaces are employed.

• Nuclear Medicine: Automatic 256 x 256 and 512 x 512 Nuclear Medicine image capture systems are connected. They typically have data captured by a stand alone system and are connected to the system in a server architecture.

• Cardiac Catherterization: At the New England Medical Center the cardiac cath. lab has its digitized outputs directly networked to outlying hospitals for cardiologist evaluation.

• PET: A PET system will be connected in 1991 at the Children's Hospital.

The end users of the system and their applications are as follows:

• Radiology: This user is the primary specialist in the evaluation of the imaging results. The current methodology uses plain film in the determination of the potential pathology. The existing mechanical systems allow for rapid and efficient review of plain film. The systems are typically connected to a voice transcription system that allows for the non real-time transcription of the radiologist's findings.

• Nuclear Medicine: This area of sub-specialty focuses on the results of specific scans to determine lesion type and location and also to determine the metabolic functioning of organ specific sites. Current systems capture the information on a digital format and then support a transcription system for voice reports.

• Cardiology: The cardiologist may use the results from specific imaging modalities to determine the specific types of stenosis, occlusions or inflammations. These are currently done on the basis of hand-drawn results prepared by the radiologist and then sent to the cardiologist with a copy of the transcribed report.

• Surgery: The surgeon has a general need for imaging results for both surgical planning and staging. The ability to use the images from MRI and CAT systems in a surgical staging process has resulted, in several cases, in a 50% reduction in the overall surgical procedure time. For example, in the area of maxial facial surgery, it has been reported that a reduction in operating room time from six to three hours has been achieved.

• Urology: The system has been developed for utilization in the area of urology. In particular, there is a need by the urologist to determine the cause of renal system blockage, and this is accomplished by a nuclear study.

• Neurology: The study of such neurological disorders that are metabolic in nature, rather than a lesion-based disorder. The use of this system in the evaluation and staging of therapy for such disorders as Multiple Sclerosis has resulted in significant reduction in patient morbidity.

The imaging requirements have been developed in conjunction with multiple departments in various operational modes. Specifically, the following represent the overall requirements that were used for the development of the system:

• Ready access to multiple sources of image information stored on different machines in different formats and in different locations.

• The sharing of the information amounts distributed users at the same time possible on different display devices.

• The ability to process the images for the purposes of enhancement and evaluation by application software that may be developed by the end user.

• The ability to transport the images of high quality and high resolution in less than one second and to be comparable in end user satisfaction to any mechanical system currently available.

• The ability to combine and deconstruct complex multimedia objects including video, voice, text, image, and pointer motion, in a shared environment.

3.0 Systems Architecture

The system developed in the Boston trial is structured in four major software layers. These layers support various types of functionality of the network. Figure 2 depicts the overall architecture as viewed from the end user inwards towards the communications network. This view, it should be emphasized, is one from the communications perspective. There may be a different view from the device, database, or applications perspective.
From the communications perspective the system architecture has four layers. These are:

• Applications: The Applications layer in focused on connecting the end user to all of the external resources necessary to perform their duties. For example, the Applications layer connections may include other users, application programs, databases, and transaction systems to record patient care and expenses and to assure the proper charging of the patient record with collections of insurance payments. One of the most important features of the applications layer is that it provides an Applications Programmers Interface (API) to developers to allow them easy access to the functions of the lower layers. This interface in supported by a set of program calls termed macros.

• System Services: The System Services are an embodiment of a distributed system architecture using a client server model for the means of distribution. In the trial system in Boston, the design was based on a UNIX (TM AT&T) based system. This design also allowed for a fully open architecture design environment. The System Services supported are those of session, mail, file and directory. The access to these services is through a programming language called "primitives".

The overall network is depicted in Figure 1. It depicts the interconnection of all the users in the inter-facility network. This includes the following major links:

• DS-3 Links: These are 45 Mbps links that are the backbone of the image transfer system. The 45 Mbps link allows for the transport of a 2,000 x 2,000 pixel display, with 12 bits per pixel in about one second.

• DS-1 Links: These are 1.5 Mbps links that are used to support the transport of slower response images. For example, at this rate, a 256 x 256 cardiology display at 8 bits can be transmitted at 3 frames per second. This is about one-fifth real-time for a typical film based system.

• DS-0 Links (ISDN): These are basic rate ISDN channels at 64 Kbps. These channels are useful for the non real-time transfer of images for the inter-facility use of remote diagnosis in non-time critical fashion. In addition, such a system allows for some session interaction and support.

The System Services part of the design is the upper layer of the distributed architecture. This upper layer, just under the Applications layer, is called the shell layer.

• Network Services: The Network Services are the lower layer of the above-mentioned architecture. Network Services provides two functions: interface to the System Services and interface to the physical transport. The physical transport is the most important function since it allows any end user to access any type of transport in a transparent fashion. It further allows the applications developer to provide a bandwidth on demand capability through the primitive calls.

In the current configuration, the system supports FDDI, Ethernet, Token Ring, DS1, DS3 and ISDN.

• Transport: This is the lowest layer of the network. It allows for the type of physical transport previously described.

The four services supported in this system are:

• Session: This service provides the underlying functionality for shared conversation between the users as well as application programs, databases, and other network Input/Output devices. It supports four major elements: synchronization of the multimedia objects; dialog management between the session users; activity management of the underlying transactions; and event or network management. The Session service uses the standardized model of OSI Layer 5 protocol. Modifications and enhancements have been made to these areas based upon the structures of simple and compound multimedia objects. (See McGarty.) Images are transferred using the Sun (TM) NFS protocols. Attempts to transfer using an out of band signaling have resulted in significant delays.

Figure 3 depicts the overall client-server architecture of the Session service model.

• Mail: This is a multimedia mail service that allows the users to create compound multimedia objects and file, store, retrieve and mail them to other users on the network.

• File: This allows for accessing of different databases that may have different elements of the multimedia data objects. These data objects must be accessed on different devices, at different locations and stored in different file formats. The file system is a front-end device that assists in this process. The current system uses a separate front-end processor for the accessing of clusters of databases on different machines.

• Directory: The most difficult task in a system that has multiple users, uses and devices is the ability to find what one is looking for when it is needed. This is accomplished in this system with a multimedia directory service.

The applications currently supported are:

• Report: This application is focused on the imaging specialist and allows for the analysis for image, post-processing of the image and the annotation of the image by voice, text or other manual means. It supports the filing and retrieval of this information.

Figure 4 depicts the typical screen format for the Report applications.

• Rounds: The round application is a similar application that supports the attending physician on the patient floor.

• Consult: This application allows for the comparing and commenting upon of results that have been obtained by an imaging specialist. In the current system this application is being used in the New England Medical center for cardiac catherterization.

• MGH R-Star (TM): Massachusetts General Hospital has developed its own internal PACs system, and the above system is being integrated as the underlying network infrastructure to the R-Star application . (See Taffe.)

• Surgical Staging: At Brigham and Women's, the use of three dimensional MRI reconstruction in surgical staging for both maxial facial and neurosurgery has been developed, again using the system as an underlying fabric.

4.0 System Performance

The overall system performance is currently being tested and a detailed analytical model for the system is being developed. Specifically, the system is viewed as a fully distributed operating system with an adjunct fully distributed database capability. The system is currently designed taking into account the distributed facilities of the UNIX (TM, AT&T) operating system and its functions. The client-server structure of the architecture is built around the seven layer OSI model for computer communications allowing for an open architecture and the use of existing models for design and analysis.

The performance measures were divided into two major categories. The first are those that relate to the productivity of the service in the hospital environment and the second relate to the specifics of the system operation.

• Productivity Performance:

• Increased utilization of imaging specialist time due to reduced access time for images and records.

• Increased availability of records stored from previous examinations.

• Minimization of applications development time for new end user applications.

• Reduce costs on a per exam basis.

• Allow for the increased throughput in each imaging facility.

• Attain the acceptance of both imaging and non-imaging physicians in the use of the system in patient support environments.

• Allow for the ready integration into the existing hospital HIS system.

• System Operation Performance:

• Provide a response time per user that is comparable to or better than current physical systems.

• Provide for an availability on an end-to-end basis in excess of 99.8%.

• Provide for transport that does not require any image compression techniques.

The detailed systems performance analysis has been performed and the results are presented elsewhere. At this point, however, it is clear that a fully distributed architecture provides for the optimum performance. Specifically, if the OSI layer 5, Session Services, are provided in the end user terminals rather than in a central node, the delays and response time are significantly reduced. Detailed analytical models are currently being developed at MIT to determine the performance in an analytical form.

5.0 Cost Model

In the cost model we have developed a methodology that was based on the operations of existing imaging centers and have made it extensible to other centers. The model consists of the following elements:

- Information Workflow Model (IWM): This model consists of a detailed analysis of the current work in an imaging center, carefully measuring and documenting each step that is required for the delivery of a service, determining the time taken for that step, and determining the type of person involved in that step. Specifically, the approach first details all of the steps in the delivery of the procedure. Then, measurements are made on each of the steps to determine the average and minimum times required. Then each step is examined for its ability to be replaced or enhanced by a computer-based system. Then, the interaction of the steps are determined, and the interaction is evaluated on the impact of an electronic information system. A total system flow diagram is then prepared.

- Cost Allocation Model (CAM): For each step in the IWM, a detailed cost allocation procedure can be performed. This procedure is based on a three element model that includes the operations driver, the productivity factor and the unit cost. This model is extensively developed in McGarty [89]. Specifically, each task element has a cost, C_k, associated with it. C_k is given by: $C_i = UC_{ij} P_{ij} D_{ij}$
where:

  - UC represents the unit cost of labor j on task i;

  - P is the productivity of task i by unit contributor j;

  - D is the driving factor for the cost i.

  Thus, we can consider the driver as the number of patients, the productivity of a task as the number of minutes per patient as determined from the IWM, and the unit cost the fully loaded salary of the worker on that task.

- Economic Performance Model (EPM): The EPM combines the results from the IWM and the CAM into a detailed trade-off model that allows for the dynamic analysis of the total cost and operations structure.

In this study we have performed a detailed analysis of three hospitals, focusing on three different departments. Specifically, we have analyzed the radiology, nuclear medicine and cardiology imaging departments in the hospitals. We now present a detailed analysis summary of the nuclear medicine facility. We have considered three differing scenarios. They are:

- Case I (Current): This is the current operation and the results of the IWM are presented in Figure 5.

- Case II (Imaging System Only): In this case we introduced the imaging system into the operations of the department. This has resulted in significant reductions in tasks and in the resulting reduction of costs. Figure 6 depicts the changes in the IWM for this approach.

- Case III (Fully Integrated Image and HIS System): In this case we further integrated the HIS into the imaging system to determine the increased savings. It is clear from the IWM model of Figure 7 that there is a further reduction in tasks. These are reflected in the overall cost reduction.

We have used costs factors for this department and have performed a detailed economic trade-off analysis. Specifically, we have parameterized the cost per exam as a function of the total exams through the department, doing so for each of the three cases. The results are shown in Figure 8. This clearly shows for the following:

- At high levels of utilization the unit costs are fairly constant. This means that there are clear scale economies in that the average costs equal the main costs.

- At the lower levels of utilization there is a five times greater unit cost that must be borne by the facility, primarily due to the lack of utilization.

- The impact of imaging results in a 40% unit cost reduction in the flat region. The added impact of HIS interface is a total 45% reduction, but only 5% greater than imaging alone. Thus, imaging systems integration has the most dramatic impact on the system performance.

- These results, although prepared based on a single imaging modality, have been directly extended to other modalities.

The detailed cost allocation analysis for the full scale costs of Cases I, II and III are presented in Figure 9.

6.0 Transaction Management

Each time a procedure is performed on a patient, whether directly or otherwise, this is viewed as a transaction. The objective of the overall system design is to be able to capture all such transactions. Furthermore, a transaction has two elements--the revenue generating side and the expense creating side. The capture of each transaction assumes that the system is capable of handling both sides of the transaction equation.

In the context of overall hospital operations, the revenue capture is reflected in the accounts receivable file while the expense structure is the accounts payable. The difference of the two is the working capital requirement for the institution. The effective management of a hospital is the management of the cash flow. The key ingredient in cash flow management is working capital management. Moreover, to improve the hospital systems operations means focusing not only on cost reduction but also on revenue capture. Both result in better working capital management. Thus, this current system design is ultimately focused at reducing the overall working capital requirements for the health care institution.

The transaction process is demonstrated in Figure 10. Here we have shown the capture of the information on all transactions, (an essential capability of this distributed network), and the management of the payables and receivables. On the receivables side, it is essential to have an electronic interface into the Medicare, Medicaid, and third party insurer networks. In the current system this is accomplished by means of POS stations, workstations providing existing services, via special purpose software. The current design has used the PROBITY TM product of LaPook Lear Systems. The PROBITY product acts as a front-end in the POS (Point of Service) system and provides for the capture of the information on each patient transaction. The system also provides a back-end processing interface for the transfer of the billing records electronically to the insurers. This is especially critical given current requirements of insurers. The system also allows for an Expert System-based interface to minimize the usage of improper billing numbers.

7.0 Conclusions

This trial has led to several early conclusions. They are based upon the testing of the system in an operational environment, and it is the contention of the current study that the results are projectable to other institutions in other environments.

• Multimedia Systems Applications must be developed by the users to meet the specific needs of the local institution. The development environment must be flexible enough to allow for the implementation of applications that are transparent to both the communications channels as well as the specific structure and storage locations of the data.

• Multimedia Systems must be integrated into the overall HIS environment. A stand alone system allows only for cluster communications and cluster applications. These may be adequate for local acceptance, but it is essential to have not only hospital-wide acceptance but also community-wide acceptance.

• Transaction-based environments allow for the optimization of the working capital management of the hospital environment. The system must integrate the utilization of staff time, the application of staff resources, the use of inventory items, and must allocate these to specific codes that can be billed electronically to the appropriate carrier. This focuses the process on managing working capital, specifically accounts receivable and accounts payable.

• Cost savings in an operation context of an imaging center can be achieved if there is an adequate throughput in the center. Frequently, the level of utilization is so low that fixed costs significantly outweigh the variable and, thus, the centers are inefficient. This is especially true of specialty imaging centers such as Nuclear Medicine.

Acknowledgments

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Figure 1

Boston Trial Network

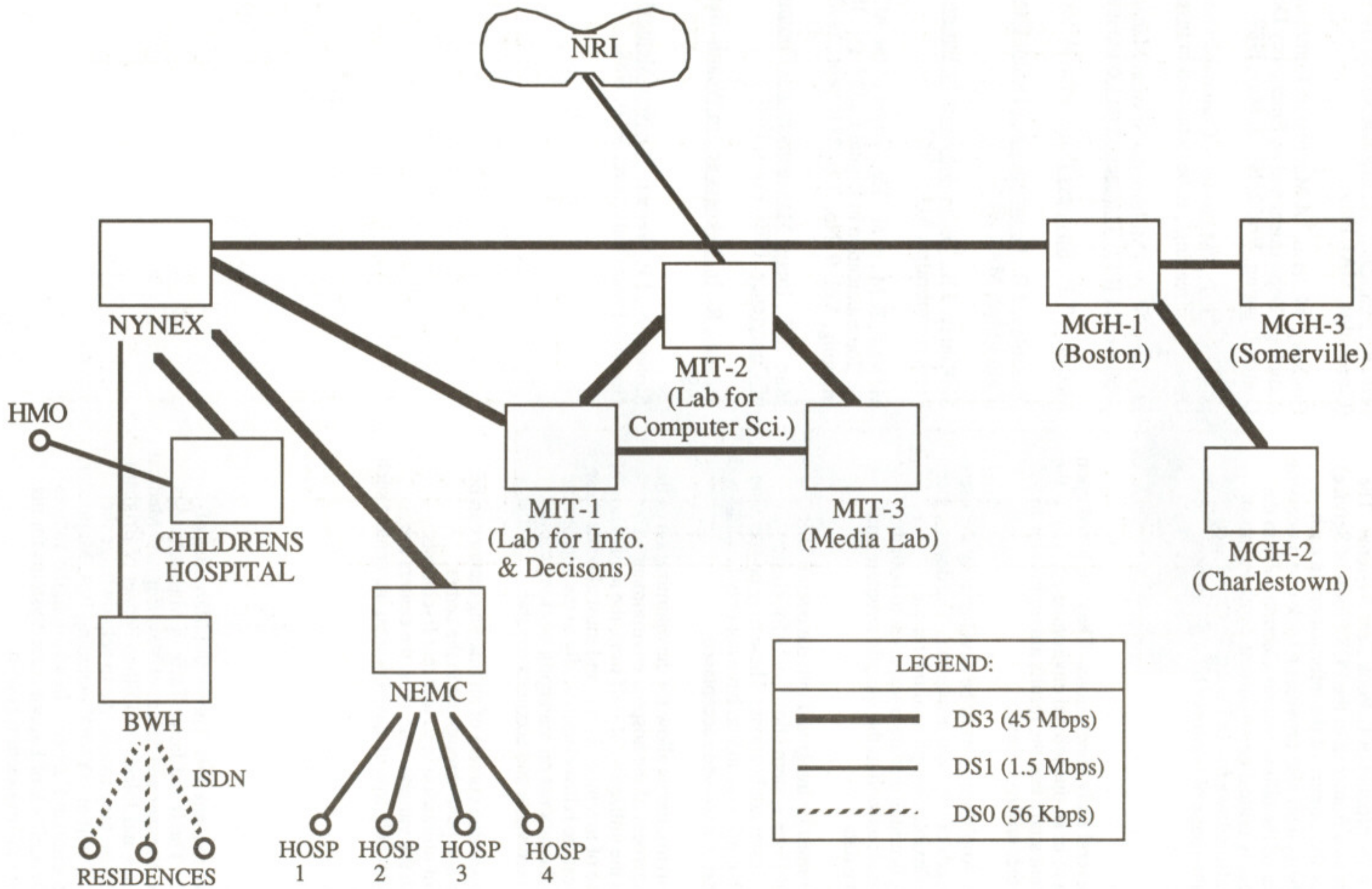

Figure 2

Multilayer System Architecture

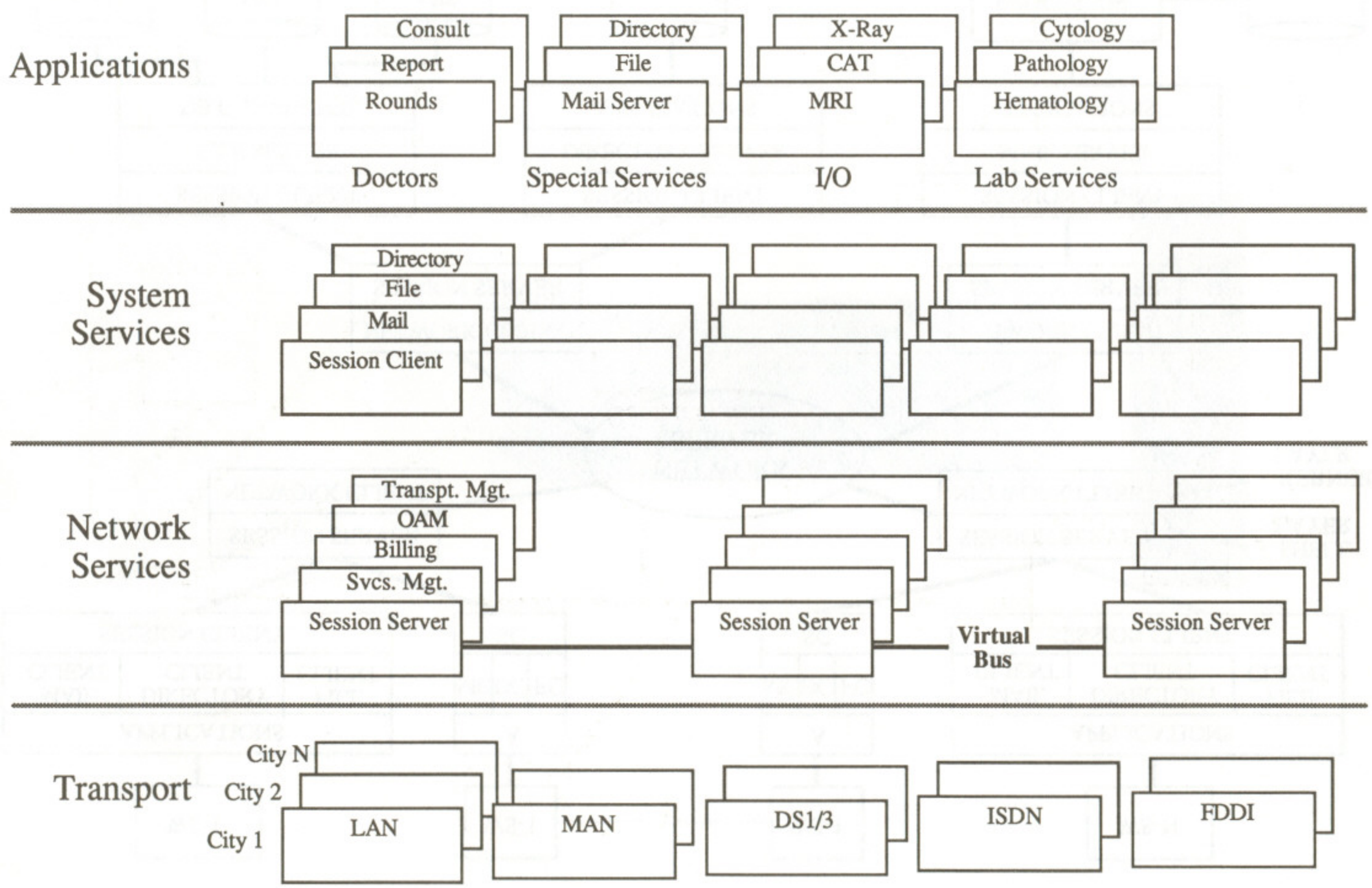

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Figure 3

Client Server Model

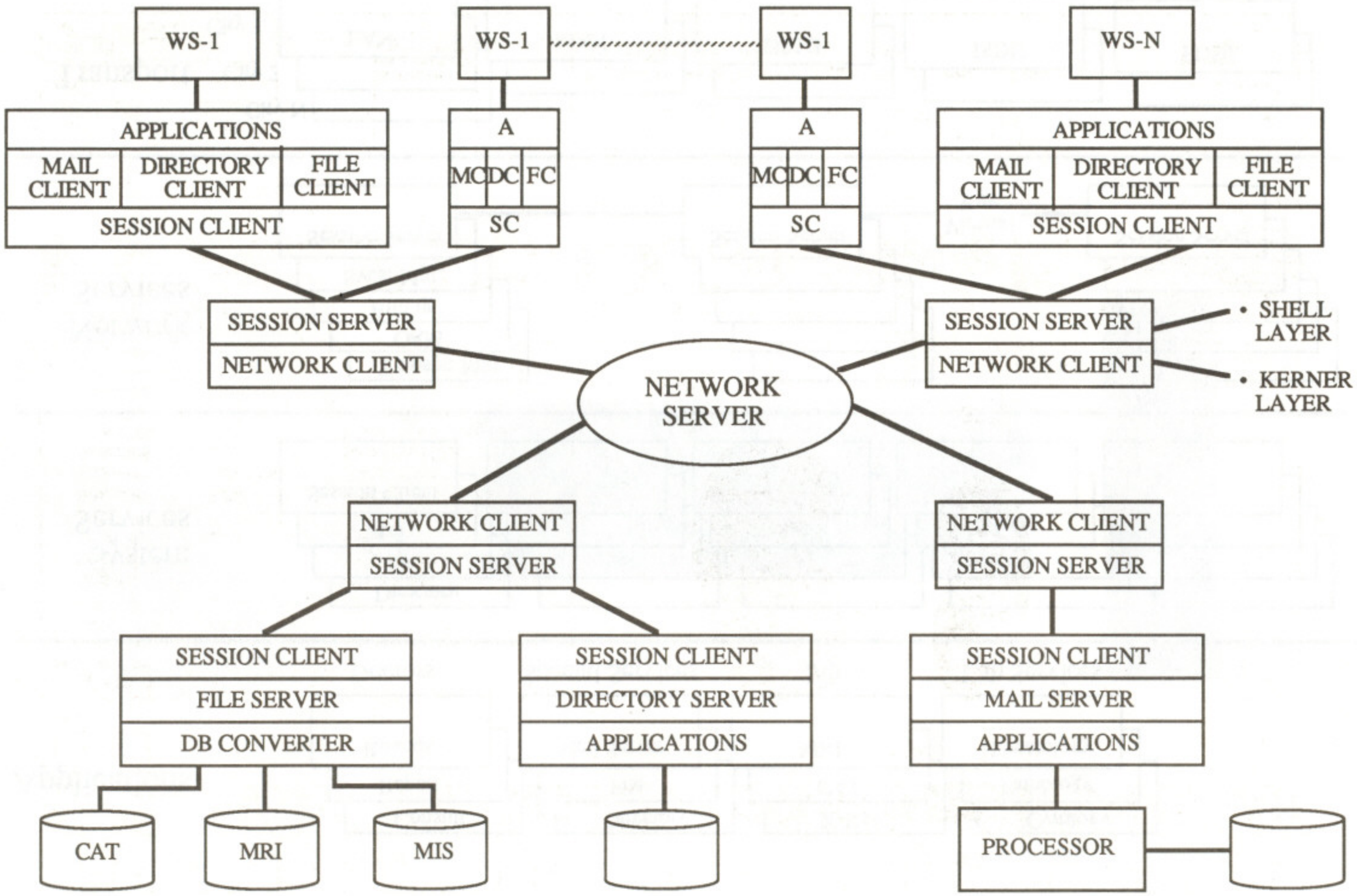
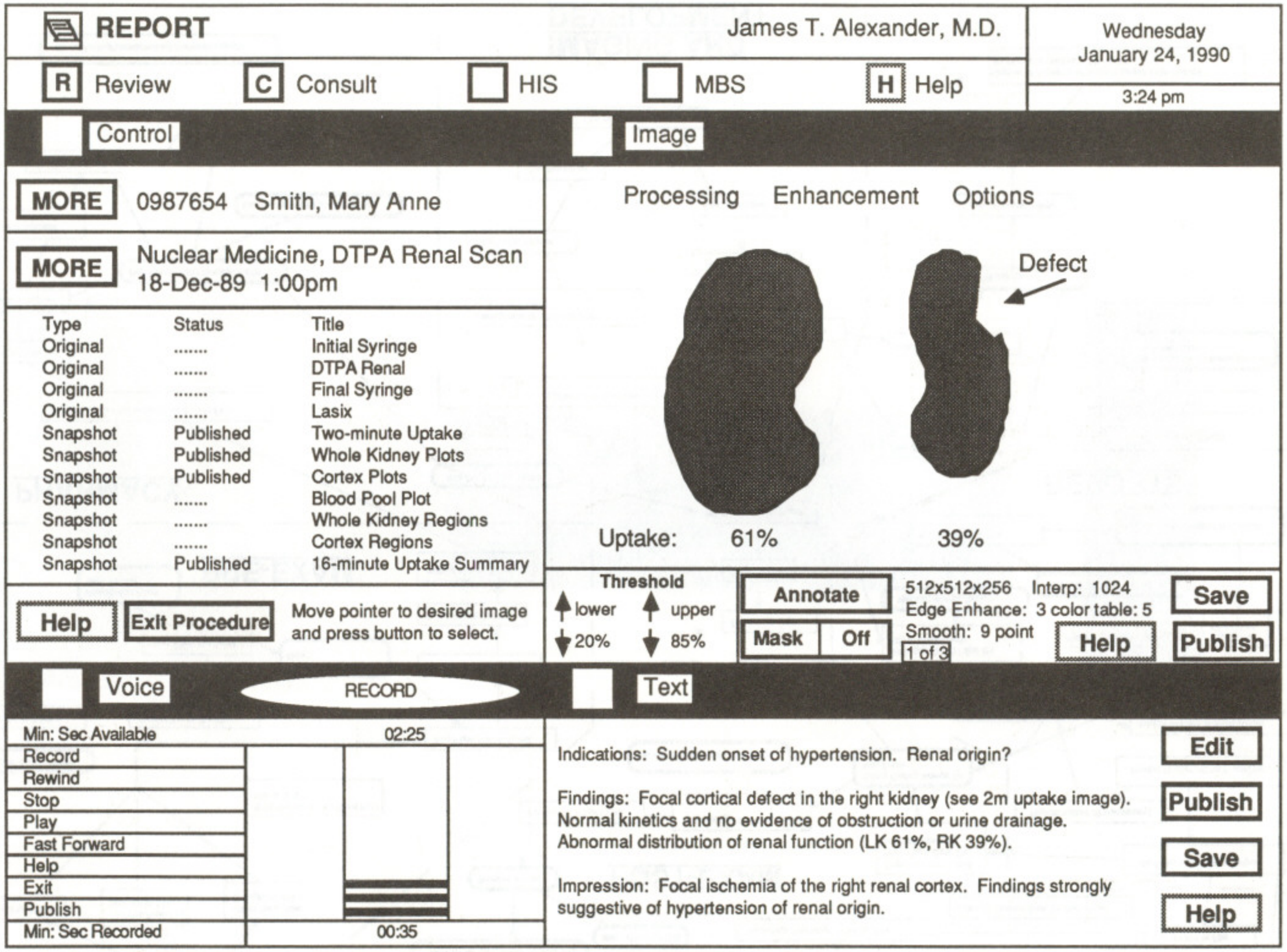


Figure 4



REPORT
James T. Alexander, M.D.
Wednesday
January 24, 1990
3:24 pm
R Review
C Consult
HIS
MBS
H Help
Control
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MORE
0987654 Smith, Mary Anne
MORE
Nuclear Medicine, DTPA Renal Scan
18-Dec-89 1:00pm
Type Status Title
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Original .... DTPA Renal
Original .... Final Syringe
Original .... Lasix
Snapshot Published Two-minute Uptake
Snapshot Published Whole Kidney Plots
Snapshot Published Cortex Plots
Snapshot .... Blood Pool Plot
Snapshot .... Whole Kidney Regions
Snapshot .... Cortex Regions
Snapshot Published 16-minute Uptake Summary
Help
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Move pointer to desired image and press button to select.
Processing
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Options
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Uptake: 61% 39%
Threshold
lower 20%
upper 85%
Annotate
Mask
Off
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Edge Enhance: 3 color table: 5
Smooth: 9 point
1 of 3
Help
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Voice
RECORD
Text
Min: Sec Available 02:25
Record
Rewind
Stop
Play
Fast Forward
Help
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Min: Sec Recorded 00:35
Indications: Sudden onset of hypertension. Renal origin?
Findings: Focal cortical defect in the right kidney (see 2m uptake image). Normal kinetics and no evidence of obstruction or urine drainage. Abnormal distribution of renal function (LK 61%, RK 39%).
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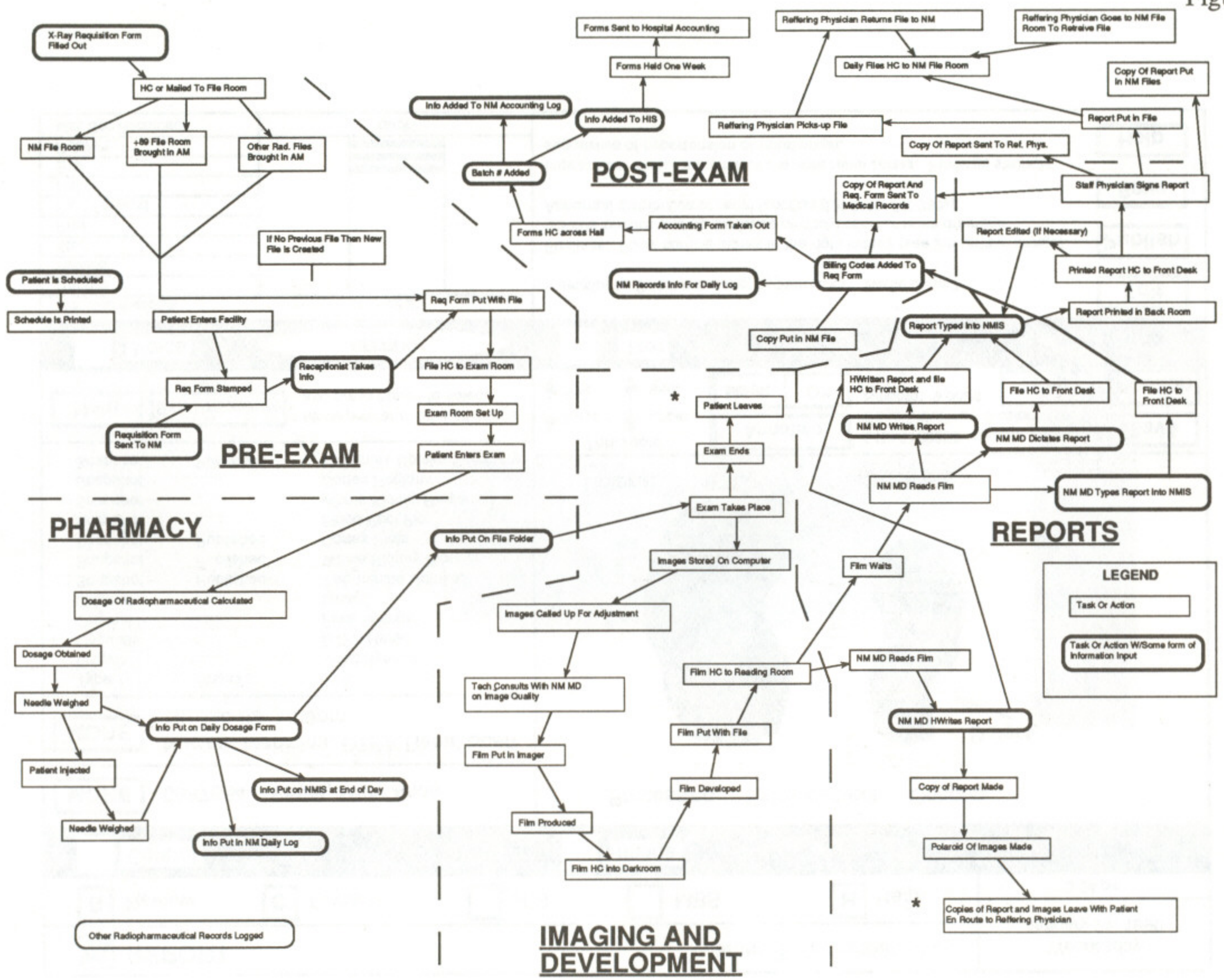
Figure 5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HC or Mailed To File Room
NM File Room
+89 File Room Brought In AM
Other Rad. Files Brought In AM
If No Previous File Then New File Is Created
Patient Is Scheduled
Schedule Is Printed
Patient Enters Facility
Req Form Stamped
Receptionist Takes Info
Requisition Form Sent To NM
Req Form Put With File
File HC to Exam Room
Exam Room Set Up
Patient Enters Exam
PRE-EXAM
PHARMACY
Dosage Of Radiopharmaceutical Calculated
Dosage Obtained
Needle Weighed
Info Put on Daily Dosage Form
Patient Injected
Needle Weighed
Info Put on NMIS at End of Day
Info Put In NM Daily Log
Other Radiopharmaceutical Records Logged
Info Put On File Folder
Info Added To NM Accounting Log
Batch # Added
Info Added To HIS
Forms Held One Week
Forms Sent to Hospital Accounting
POST-EXAM
Forms HC across Hall
Accounting Form Taken Out
NM Records Info For Daily Log
Billing Codes Added To Req Form
Copy Put in NM File
Copy Of Report And Req. Form Sent To Medical Records
Reffering Physician Picks-up File
Reffering Physician Returns File to NM
Daily Files HC to NM File Room
Reffering Physician Goes to NM File Room To Retreive File
Copy Of Report Put In NM Files
Report Put In File
Copy Of Report Sent To Ref. Phys.
Staff Physician Signs Report
Report Edited (If Necessary)
Printed Report HC to Front Desk
Report Printed in Back Room
Report Typed Into NMIS
Patient Leaves
Exam Ends
Exam Takes Place
Images Stored On Computer
Images Called Up For Adjustment
Tech Consults With NM MD on Image Quality
Film Put In Imager
Film Produced
Film HC into Darkroom
Film Developed
Film Put With File
Film HC to Reading Room
IMAGING AND DEVELOPMENT
HWritten Report and file HC to Front Desk
NM MD Writes Report
File HC to Front Desk
NM MD Dictates Report
File HC to Front Desk
NM MD Reads Film
NM MD Types Report Into NMIS
REPORTS
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NM MD Reads Film
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LEGEND
Task Or Action
Task Or Action W/Some form of Information Input

Figure 6

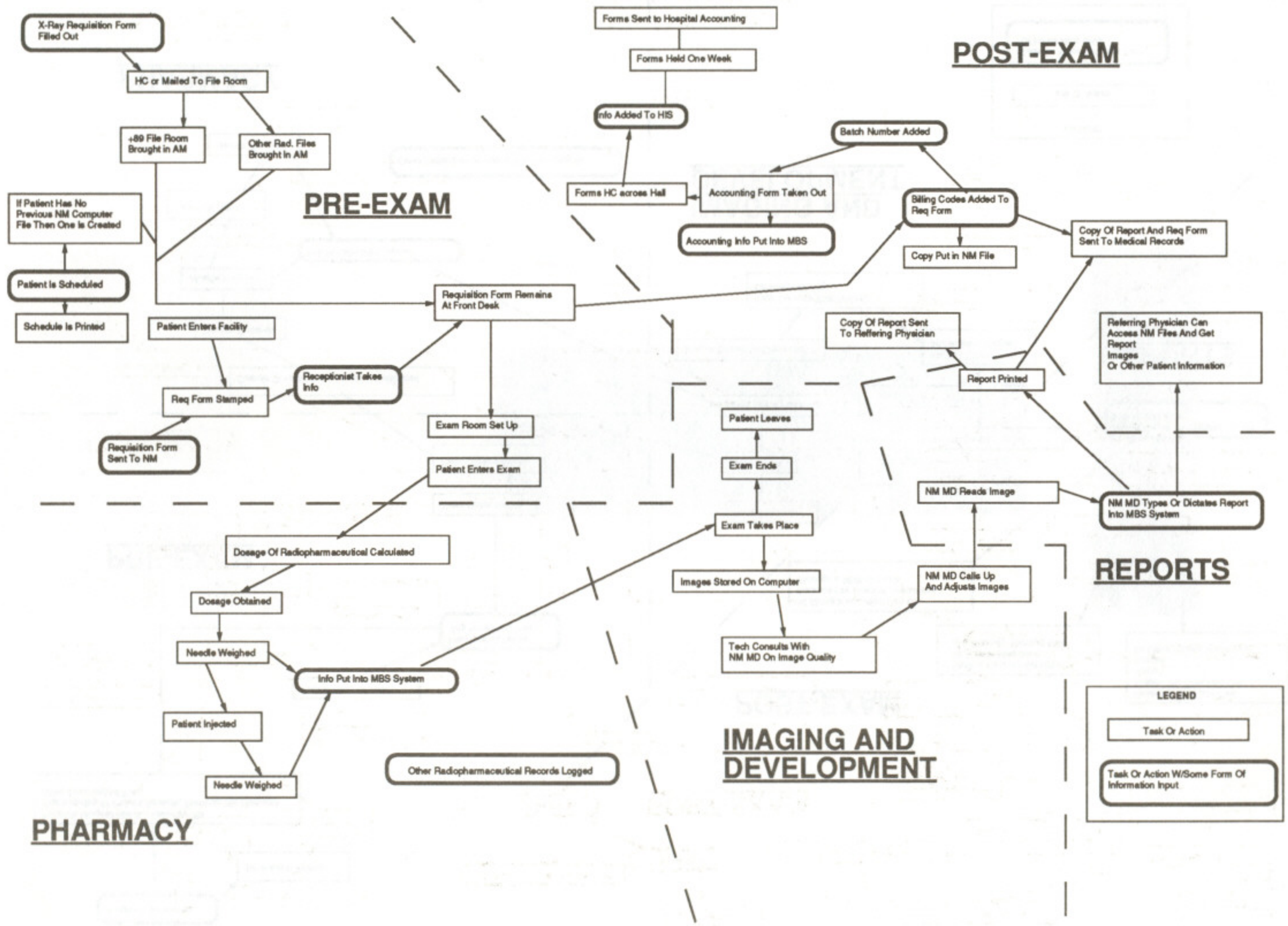
PRE-EXAM
X-Ray Requisition Form Filled Out
HC or Mailed To File Room
+89 File Room Brought in AM
Other Rad. Files Brought In AM
If Patient Has No Previous NM Computer File Then One Is Created
Patient Is Scheduled
Schedule Is Printed
Patient Enters Facility
Req Form Stamped
Receptionist Takes Info
Requisition Form Sent To NM
Requisition Form Remains At Front Desk
Exam Room Set Up
Patient Enters Exam
POST-EXAM
Forms Sent to Hospital Accounting
Forms Held One Week
Info Added To HIS
Forms HC across Hall
Accounting Form Taken Out
Accounting Info Put Into MBS
Batch Number Added
Billing Codes Added To Req Form
Copy Put in NM File
Copy Of Report And Req Form Sent To Medical Records
Copy Of Report Sent To Reffering Physician
Report Printed
Referring Physician Can Access NM Files And Get Report Images Or Other Patient Information
IMAGING AND DEVELOPMENT
Patient Leaves
Exam Ends
Exam Takes Place
Images Stored On Computer
Tech Consults With NM MD On Image Quality
REPORTS
NM MD Reads Image
NM MD Types Or Dictates Report Into MBS System
NM MD Calls Up And Adjusts Images
PHARMACY
Dosage Of Radiopharmaceutical Calculated
Dosage Obtained
Needle Weighed
Info Put Into MBS System
Patient Injected
Needle Weighed
Other Radiopharmaceutical Records Logged
LEGEND
Task Or Action
Task Or Action W/Some Form Of Information Input

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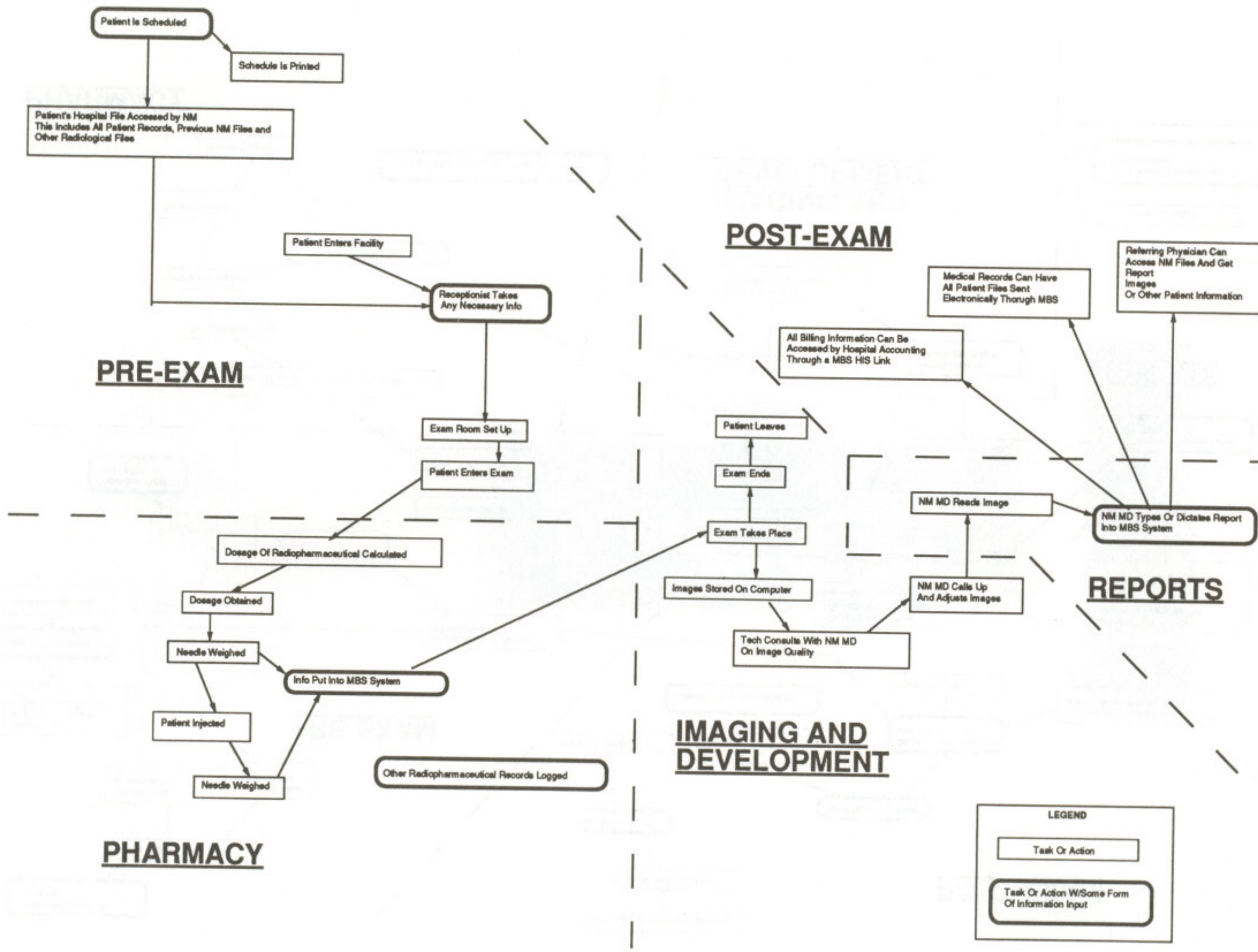
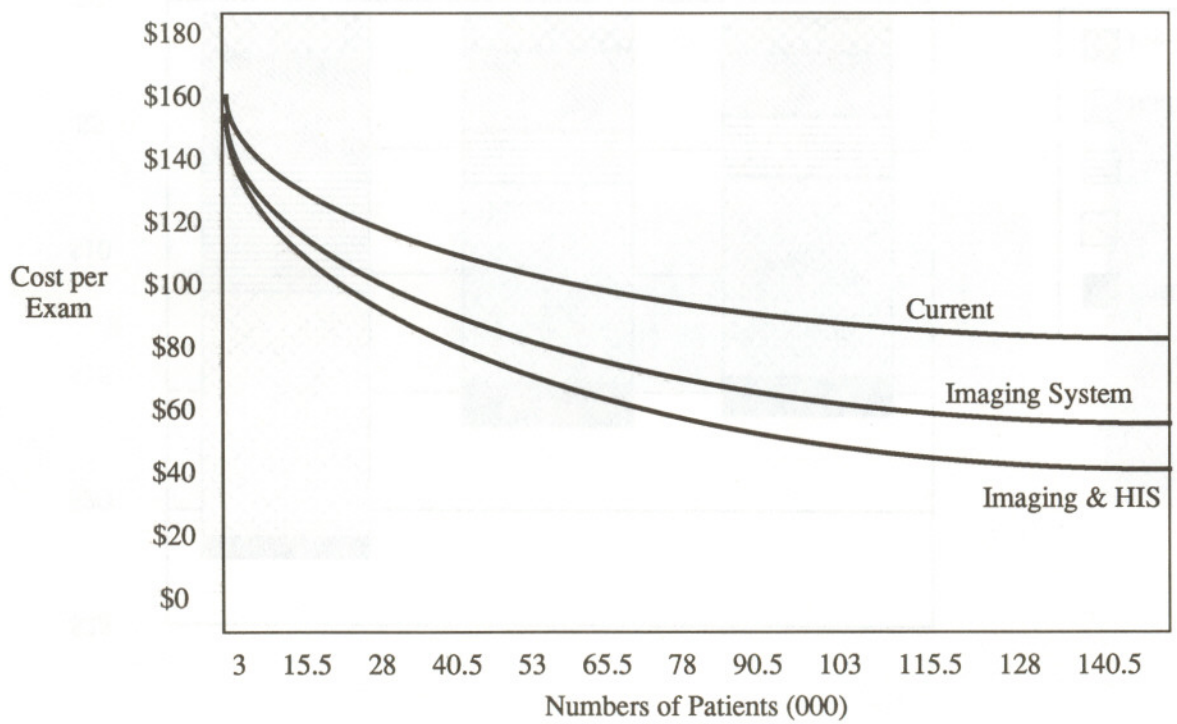
Figure 7



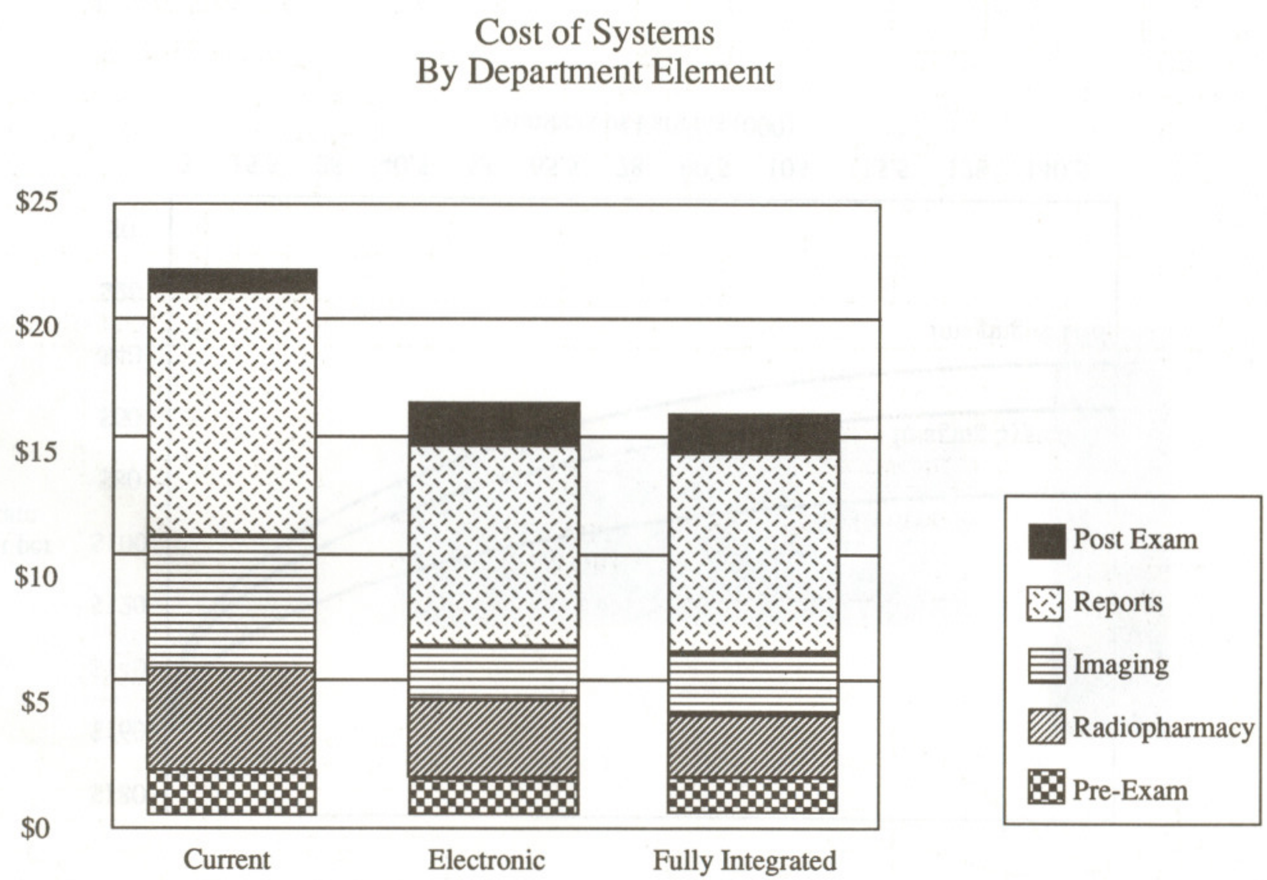
Patient Is Scheduled
Schedule Is Printed
Patient's Hospital File Accessed by NM
This Includes All Patient Records, Previous NM Files and
Other Radiological Files
Patient Enters Facility
Receptionist Takes
Any Necessary Info
PRE-EXAM
Exam Room Set Up
Patient Enters Exam
Dosage Of Radiopharmaceutical Calculated
Dosage Obtained
Needle Weighed
Info Put Into MBS System
Patient Injected
Needle Weighed
Other Radiopharmaceutical Records Logged
PHARMACY
POST-EXAM
All Billing Information Can Be
Accessed by Hospital Accounting
Through a MBS HIS Link
Medical Records Can Have
All Patient Files Sent
Electronically Thorugh MBS
Referring Physician Can
Access NM Files And Get
Report
Images
Or Other Patient Information
Patient Leaves
Exam Ends
Exam Takes Place
Images Stored On Computer
Tech Consults With NM MD
On Image Quality
NM MD Calls Up
And Adjusts Images
NM MD Reads Image
NM MD Types Or Dictates Report
Into MBS System
REPORTS
IMAGING AND
DEVELOPMENT
LEGEND
Task Or Action
Task Or Action W/Some Form
Of Information Input

Figure 8



Cost per Exam
$180
$160
$140
$120
$100
$80
$60
$40
$20
$0
Current
Imaging System
Imaging & HIS
3
15.5
28
40.5
53
65.5
78
90.5
103
115.5
128
140.5
Numbers of Patients (000)

Figure 9


Cost of Systems
By Department Element
$25
$20
$15
$10
$5
$0
Current
Electronic
Fully Integrated
Post Exam
Reports
Imaging
Radiopharmacy
Pre-Exam

Transaction System Elements

Figure 10